Title: Your Local Pond: "A Delicate Aquatic Biome"

Link to Outcomes:

● **Processes of Science**	Students will demonstrate the ability to employ the language, instruments, methods, and materials of science for collecting, organizing, interpreting, and communicating information.
● **Nature of Science**	Students will demonstrate their acquisition and integration of major concepts and unifying themes from the life, physical, and earth/space sciences.
● **Real-World Applications**	Students will demonstrate the ability to apply science in solving problems and making personal decisions about issues affecting the individual, society, and the environment.

Brief Overview:

In most communities there is a delicate balance among living organisms and abiotic factors. When people disturb that balance by altering the abiotic factors, the results are usually detrimental. In this unit the basic biology of living organisms will be challenged by chemical solutions introduced by humans. The students should be able to connect basic concepts such as eutrophication, dissolved oxygen, population density, and the societal role in maintaining this balance. They will determine the effects of phosphate concentration on dissolved oxygen and algae.

Grade/Level:

Grades 10-11

Duration/Length:

This lesson is expected to take three 90-minute class periods. Papers and debates can extend the time period.

Prerequisite Knowledge:

The students should have a basic knowledge of biological principles, to include eutrophication, aerobic and anaerobic bacteria. They should also be familiar with the operations of a microscope. Students should know the origin and effect of dissolved oxygen and phosphates on nutrient systems. They should also be familiar with preparing a line graph. Students must be shown how to use the dissolved oxygen kit.

Objectives:

- To discover how to make measurements of microscopic organisms.
- To analyze the relationship of abiotic factors to living communities.
- To relate the outcomes to real life situations.

Materials/Resources/Printed Materials:

- Microscope and spectrophotometer (optional)
- Grid Scale
- 6 - l liter flasks per group
- Source for phosphates (detergent, etc.)
- Dissolved oxygen kit
- Titrator or pipet
- Algae + aerobic bacteria (may be supplied by pond water)
- Graphing materials
- Grow light (optional)

Development/Procedures:

NOTE: refer to Biome Lab Worksheet.

- Groups of four students will set up a lab with equal volumes of algae. (Amounts to be assigned by teacher.)

- Place a specified amount of phosphate in each flask. (Amount to be determined by the teacher.) Except for the control which has no phosphate added.

- Collect qualitative data for four days.

- On the fourth day, collect quantitative data.

- Determine the dissolved oxygen using a chemical kit at the conclusion of the experiment.

- Use a microscope or spectrophotometer to measure the amounts of algae at the end of the prescribed time.

- Gather quantitative data and graph.

Evaluation:

Students will evaluate the graphs and be prepared to present the findings to the class. The general shape of the phosphate vs. algae growth graph should be a positive slope leveling off. This due to the limiting action that the phosphate has on nutrient growth. Other nutrients are usually plentiful. The graph of D.O. vs. algae growth should be a straight line with a negative slope. This is due in part to the consumption of oxygen by the aerobic bacteria.

Extension/Follow Up:

Students could research current and past government policies relating to the control of phosphate and nitrate nutrients as well as water quality in general.

Students could search for information on the conditions of local bodies of water and comment on improvement or degradations after environmental legislation has been passed.

Students could take positions as a farmer, environmentalist, waterman, developer, etc. and write a proposal in support of or against local environmental regulations.

Students could identify and monitor a local body of water for nutrient levels during the school year.

Students should be encouraged to use a computer to generate graphs.

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Resources:

1. Carolina Biological Supply Co.
   2700 York Rd.
   Burlington, NC 27215
   (800) 334-5551 (Eastern U.S.)
   (800) 547-1733 (Western U.S.)

2. Dashefsky, H. Steven. *Environmental Science*. Tab Books, 1994.
   ISBN 0-8306-4586-1.

3. Hach Co.
   P.O. Box 389
   Loveland, CO 80539
   (800) 227-4224

4. LaMotte Company
   P.O. Box 329
   Chestertown, MD 21620
   (800) 344-3100
   Dissolved oxygen kit (cat. # 7414, $32.50) *1995 price*.

BIOME LAB WORKSHEET

TITLE: The Effects of Phosphate Concentration on Dissolved Oxygen and Algae.

PURPOSE: To investigate the correlation between the amount of algae produced and dissolved oxygen by the addition of phosphates to pond water.

MATERIALS: (6) one liter flasks, phosphate solutions, dissolved oxygen kit, spectrophotomer or microscope, graphing materials

PROCEDURE:

1. Label (6) one liter flasks A - F.
2. Place 1 L of pond water into each flask. Confirm presence of bacteria and algae with a microscope.
3. Add the following amounts of phosphate to the assigned flasks.
   Flask A - 0 mg/L
   " B - 0.50
   " C - 1.00
   " D - 2.00
   " E - 4.00
   " F - 8.00
4. Place each flask under a grow light or in an area where it can receive an adequate amount of sunlight.
5. Allow the algae to set for four days.
6. On the 4th day measure the amount of dissolved oxygen in each flask using the dissolved oxygen test kit. Run three trials, record your observations and average the data.
7. Measure the amount of algae in each flask by using a spectrophotometer.
   Record qualitative and quantitative observations.
8. Graph group and class data. Algae vs. Phosphate and Algae vs. D.O. Place Algae on the y-axis.

TEACHER'S GUIDE

Experimental Design

INDEPENDENT VARIABLE - **PHOSPHATE CONCENTRATION (PO_4^{-3})**

	0 mg/L	**0.50**	**1.00**	**2.00**	**4.00**	**8.00**
D.O. mg/L						
Algae abs.						

DEPENDENT VARIABLES: AMOUNT OF ALGAE, DISSOLVED OXYGEN
CONSTANTS: TEMPERATURE, AMOUNT OF SUNLIGHT, VOLUME OF WATER, ETC.
CONTROL: O mg/L PHOSPHATE

NOTE 1:

Setting up equal amounts of algae: The pond water will contain different types of algae, however, the various types will not be a factor because equal amounts can be achieved by thoroughly mixing the initial collection vessel just prior to dispensing. Algae can be observed in a drop of water under a microscope.
If using commercial algae and aerobic bacteria, place the algae stock in 500 mL of dechlorinated water. Take 20 mL of this mixture (after thorough agitation) and add it to 1 liter of dechlorinated water. If using commercial algae, oscillatoria might be a good choice; it is available from Carolina Biological Supply.

NOTE 2:

During the four day wait, the teacher should discuss the inhabitants of a pond community. Have the students diagram different food chains within the pond. Show how each food chain could be affected by the conditions of eutrophication and algal blooms. The most common effect would be the ultimate using up of dissolved oxygen, causing fish and other oxygen-consuming organisms to suffer. Another effect could be the explosive growth of algae over the surface of the pond, blocking light to photosynthesizing organisms. Review the equations for photosynthesis and cellular respiration as they relate to this situation. Also discuss sources of the nutrients (farm fertilizer and household products, etc.) and how these sources can be changed. The teacher should stimulate discussion of the rights and responsibilities of all parties that could impact on water quality. Invite discussion on how negative impacts on water quality will ultimately affect all consumers.

NOTE 3:

Measuring algae with a microscope:
Mix the solution thoroughly. Place measured drops of water/algae on a gridded slide. If you do not have gridded slides, attach regular graph paper under a clear slide. Count the amount of algae found per box. This gives the amount of algae for that measured drop of water. Set up a proportion to determine the approximate amount of algae per flask. For example, if the count is 121 algae cells in 0.5 mL of water; set up a proportion of
121 cells/0.5 mL = x cells/1000 mL = 60,500 algae cells. (Note: H. Steven Dashefsky's text on Environmental Science provides a good technique for counting algal cells.)

NOTE 4:

The teacher may want to leave the flask and contents intact in order to do further readings.

NOTE 5 :

Phosphate preparation: If 1 liter flasks are not available, 500 *ml* flasks will suffice. When preparing concentrations of phosphate for the 500 *ml* flasks, take dilutions of the 8 *mg/l* solution as follows: 8 *mg* of phosphate can be added to a 1 liter volumetric flask and distilled water added to the mark. To prepare the 4 *mg/l* concentration take 500 *ml* of the 8 *mg/l* solution and add to a 1 liter volumetric flask and dilute to the mark with distilled water. Repeat this sequence until you have 500 *ml* of the 0.50 *mg/l* solution. If you do not have a balance that measures tho the .001 *g* for the beginning solution, use 10 *mg/l* and a centigram balance for your most concentrated solution. The additional concentrations would then be 5.00, 2.5, 1.25, and 0.625 *mg/l* respectively.

DATA TABLE

Phosphate mg/L	D.O. mg/L Trial 1	D.O. mg/L Trial 2	D.O. mg/L Trial 3	D.O. mg/L Avg.	Algae abs. Trial 1	Algae abs. Trial 2	Algae abs. Trial 3	Algae abs. Avg.
0								
0.50								
1.00								
2.00								
4.00								
8.00								